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SURVEY NOTES

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PETROLEUM ACTIVITIES IN UTAH 1972-82

By KARL W. BROWN

INTRODUCTION

UTAH is an oil and gas producing State with approximately 3000 holes drilled for oil and gas during the period 1972-82. Approximately 60 percent of these holes resulted in production of oil and/or gas; many other holes had shows of oil and gas which were not considered to be economical. This high percentage of producing wells is mostly a result in development drilling in known field areas.

Most of the drilling during this ten-year period occurred in four principle oil and gas provinces within the State. They are: Paradox Basin, Uncompahgre Uplift, Uinta Basin, and Thrust Belt. (fig. 1).

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CHALK CREEK OIL OPERATIONS

PHOTO: KAY BOULTER

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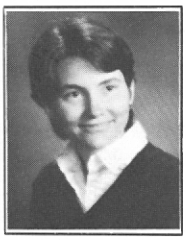

FROM THE DIRECTOR'S DESK

Priorities for Geologic Investigations in Utah

IN MID-July 1984, I convened a workshop meeting of geologists and geophysicists working in Utah to discuss "our current understanding of Utah geology, and analyze which types of questions have the greatest potential to be 'answered' in the next decade." The 32 attendees at the workshop, held at Alta Lodge in Little Cottonwood Canyon, July 10 and 11, included representatives from the State and Federal geological surveys, Utah universities, mining companies, and private consultants.

Why did I convene this workshop? Steve Oriel, USGS geologist and member of the UGMS Map Standards Committee, had, among others, encouraged me to hold the workshop to get input from well-known geologists cognizant with Utah. The purpose was to examine priorities for geologic investigations in Utah, not only for the UGMS but for non-UGMS geologists as well.

I wanted answers to such questions as:

1. Which major Utah geologic problems are timely and can be addressed effectively?

2. What scientific problems should be addressed earliest?

3. What major scientific problems with societal implications are more amenable to solution by regional mapping than by other approaches?

4. From the collective knowledge of the assembled experts, what geology-related problems are likely to be faced by the citizens of Utah which are not as yet recognized by political leaders?

Six topics were addressed; these were scheduled as concurrent pairs: 1) Structure and Composition of the Earth; and 2) Dating Geologic Materials; 3) Geologic Hazards and; 4) Hard Rock Resources; 5) Sedimentary Rocks (Basins); and 6) Surface Mapping. Most participants attended the three sessions of most interest to them, some attended parts of all six sessions, and a few participants attended only one or two sessions. On the afternoon of the second day, all of the participants met together while the chairman of each session presented a summary of his discussion topic so that each participant was able to add his comments.

WORKSHOP ACCOMPLISHMENTS

The workshop examined priorities for geologic investigation for UGMS and non-UGMS geologists alike. The following themes emerged that related primarily to the UGMS program:

TEAM APPROACH

Big geologic questions are best attacked by multidisciplinary teams of scientists. UGMS geologists are logical members of such teams although our role differs considerably with the question being addressed. For instance, we have a co-equal footing when addressing applied problems such as geologic hazards, whereas we have a more supportive role when addressing issues of fundamental research such as the structure and composition of the earth.

UGMS AS A REPOSITORY

One of the most supportive roles for the UGMS is to provide a repository for unpublished geologic information such as measured sections and mine maps, or to act as a clearinghouse for information such as geochronometric dates. The UGMS also can act effectively as a publications outlet for back-

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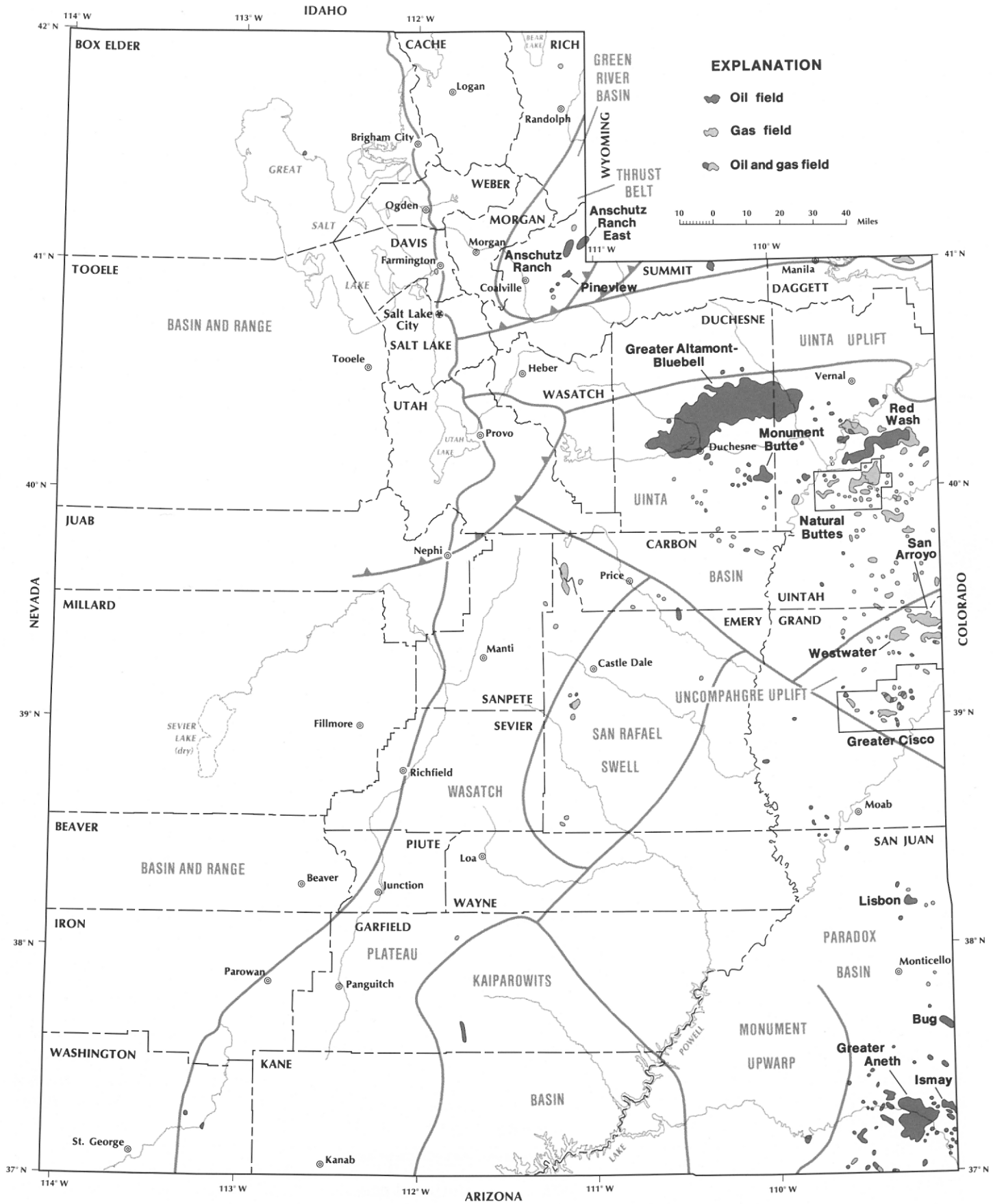

FIGURE 1. Petroleum provinces of Utah. *Continued from Page 1*

PARADOX BASIN

PARADOX Basin is located in extreme southeastern Utah in what is known as the Four Corners area (fig. 1). The principal oil and gas fields and and the year of discovery are: Aneth (1956), Lisbon (1960), and Ismay (1956), with the newest fields being Bug (1980), Squaw Canyon (1980), Mustang Flat (1982), and Tin Cup Mesa (1982).

Figure 2 shows oil and gas production of selected fields in the Paradox Basin; the dark screen pattern depicts the oil produced in 1982 and the light screen pattern shows the all-time cumulative through 1982. Gas production is also depicted with the dark screen pattern showing the gas produced in 1982 and the light screen pattern showing the all time cumulative through 1982. This same legend will apply on the subsequent production graphs (figs. 3, 4, and 5).

Most of these fields (fig. 2) produce oil and gas from the Paradox Formation, with the Ismay and Desert Creek Members as the most prolific zones. The exception is the Lisbon field which produces from the Leadville Formation of Mississippian age.

Figure 2 also shows the production from selected fields for 1982 and cumulative production figure through the year 1982. The total production for the basin was approximately 7.9 million barrels of oil and 25.0 billion cubic feet of gas for the year 1982. The wells drilled in the Paradox Basin average 6,000 feet in depth and cost approximately $600,000 for a producing well and $400,000 for a dry hole in 1982.

UNCOMPAHGRE UPLIFT

THE Uncompahgre Uplift is a relatively small oil and gas province located in northern Grand County in east central Utah between the Paradox Basin and the Uinta Basin (fig. 1). Although small in areal extent, this province includes 20 to 25 producing fields. The principal fields are: Greater Cisco (1925 and 1962); San Arroyo (1955); Bar X (1948); and Westwater (1957) which produce primarily gas from the Dakota-Cedar Mountain Formation of Cretaceous Age and the Morrison and Entrada Formations of Jurassic Age.

Only a small number of new fields were discovered in the past decade but the lack of discoveries has not slowed the pace of drilling. Most operations have been infill drilling in well-established producing areas.

The production for 1982 of the principal fields of the Uncompahgre Uplift area is shown on figure 3 with the total production for the province being 222,000 barrels of oil and 9.0 billion cubic feet of gas. The wells range in depth from 1,500 to 9,000 feet and cost $300,000 for a dry hole and $500,000 for a producer.

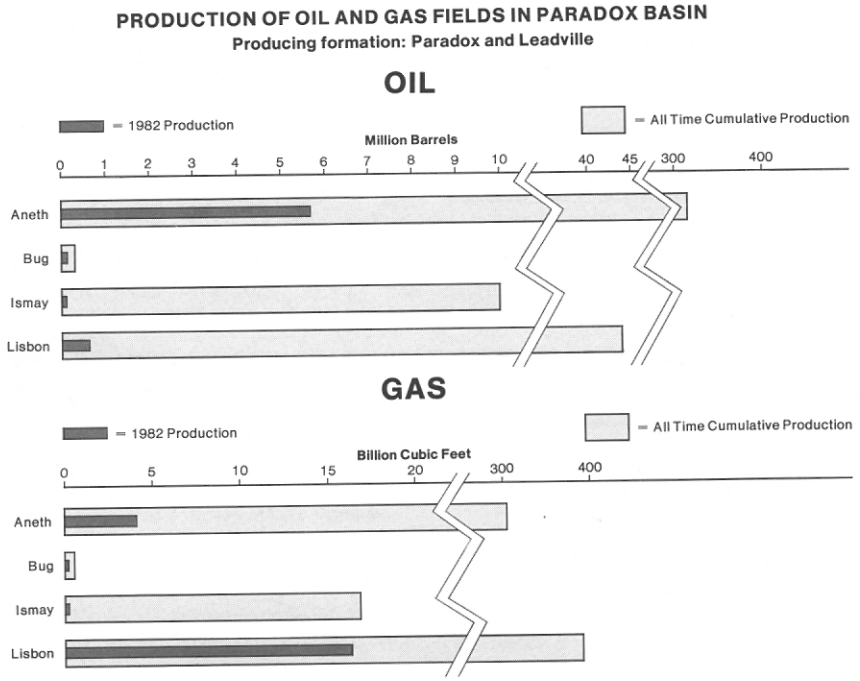

FIGURE 2.

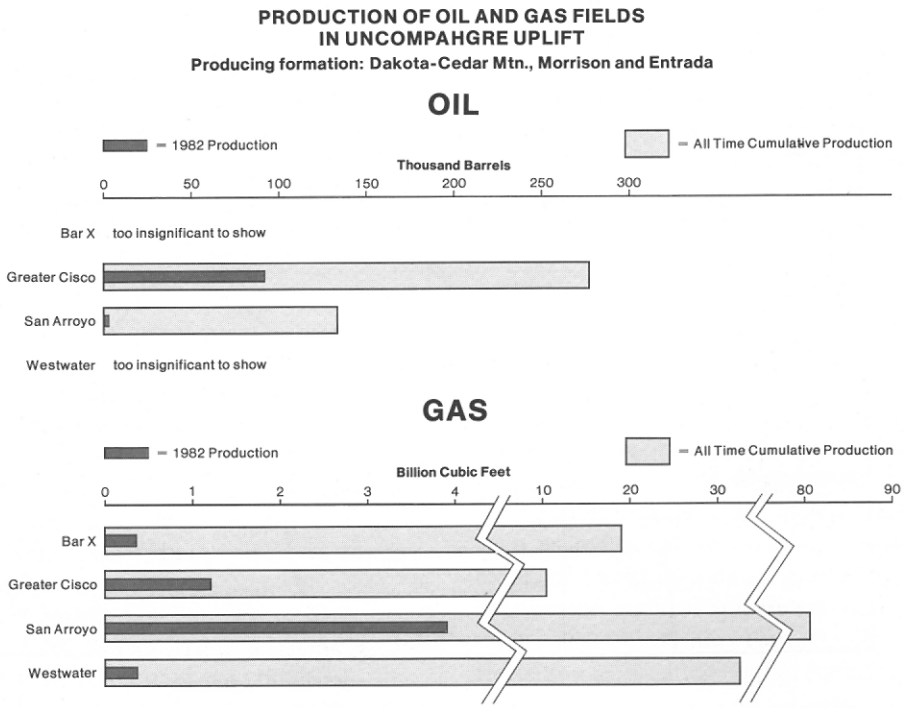

FIGURE 3.

UINTA BASIN

This oil and gas province is located in northeast Utah on the south flank of the Uinta Uplift (fig. 1). It is bordered by the Uinta Mountains, the Uncompahgre Uplift, the Wasatch Plateau, and the mountains of western Colorado.

This extensive area is a very prolific petroleum producing province with the Green River and Wasatch Formations of Tertiary (Eocene) age as the principal producing formations. Some of the larger and most important fields of the basin will be discussed because of their significance to Utah's petroleum industry.

Altamont-Bluebell (Discovered 1955 and 1972) — This giant complex is by far the largest field in the basin, covering 12 townships in Duchesne and Uintah Counties. Production of both oil and gas comes primarily from the Green River and Wasatch Formations at a depth of 4,000 to 18,000 feet.

The field was originally spaced on 640 acres per well but infill drilling is now taking place, as a pilot project, to see if additional wells can increase overall production . This pilot project is under evaluation by the Utah Division of Oil, Gas and Mining.

This field produced 7.5 million barrels of oil and 21.0 billion cubic feet of gas in 1982 and has an all-time cumulative of 148+ million barrels of oil and 199+ billion cubic feet of gas (fig. 4).

Greater Red Wash Field (Discovered 1951) — This field is principally an oil producing area in central Uintah County with production from the Green River and Wasatch Formations. However, on the extreme eastern edge of the field, gas is produced from the Mesaverde Formation of Cretaceous age.

In 1982 the field produced 2.7 million barrels of oil and 4.2 billion cubic feet of gas with an all-time cumulative of 120.5 million barrels of oil and 330.2 billion cubic feet of gas (fig. 4).

Natural Buttes Field (Discovered 1952) — This field has been expanded since its discovery to include a number of smaller fields and now extends through three townships in south central Uintah County. There is significant drilling activity in the area and it appears the field will continue to expand.

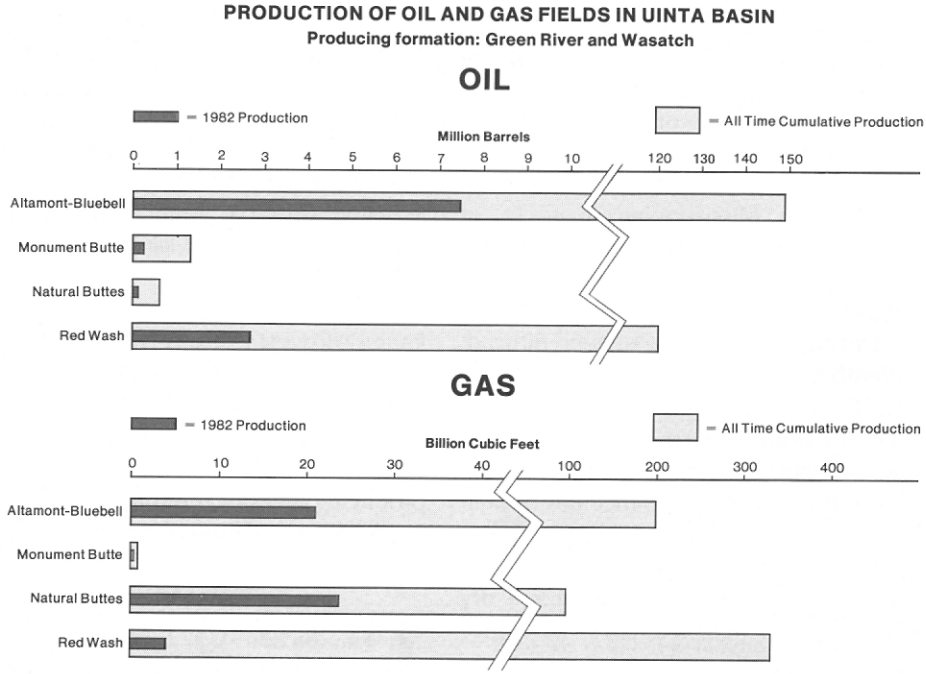

FIGURE 4.

This area produces gas from the Green River and Mesaverde Formations and oil and gas from the Wasatch Formation. In 1982, 178,000 barrels of oil and 23.9 million cubic feet of gas were produced with all-time cumulative production of 608,000 barrels of oil and 97.9 billion cubic feet of gas (fig. 4).

Monument Butte Field (Discovered 1964) — This field is located in southeastern Duchesne County and, as with other areas of the basin, it is expanding tremendously with the renewed drilling activity. The field boundaries have already been extended to cover approximately two townships and further field expansion is now being contemplated.

Production of oil and gas comes from the Green River Formation with 221,000 barrels of oil and 172,000 million cubic feet of gas in 1982. All-time cumulative production is 1.3 million barrels of oil and 621 million thousand cubic feet of gas (fig. 4).

There are numerous smaller fields in the basin but space limitations will prevent discussion of these fields here. With the renewed drilling activity, a number of new fields have been discovered. Among them: Antelope Creek, Eight Mile Flat North, Pine Springs, and a number of small fields in south central Uintah County as yet unnamed. Most of these new fields produce from the Green River Formation.

The total production from the Uinta Basin in 1982 was 11.9 million barrels of oil and 42.7 billion cubic feet of gas with an all-time cumulative figure of 156 million barrels of oil and 485 billion cubic feet of gas.

THRUST BELT

THIS large and relatively new oil and gas province is located in Summit County in north central Utah at the Utah-Wyoming State line (fig. 1). The discovery field (Pineview) is located in Utah and the producing area now extends into southwestern Wyoming where prolific oil and gas fields have been discovered.

The Utah portion contains eight producing fields: Pineview (1975), Lodgepole (1977), Elkhorn (1977), Anschutz Ranch (1979), Anschutz Ranch East (1980), Cave Creek (1980), Aagard Ranch (1982), and Pineview North (1982). Figure 5 shows the production from Anschutz Ranch, Anschutz Ranch East, and Pineview, the three most productive fields of the area. The total production for the area was 2.8 million barrels of oil and 20.6 billion cubic feet of gas during 1982. Most of these fields have not been completely outlined yet and additional drilling is taking place.

As shown on the stratigraphic chart (fig. 6), these fields produce from nine

different formations ranging in age from the Upper Cretaceous to the Mississippian. The Twin Creek Limestone and Nugget Sandstone of Jurassic age are the principal producing formations. (Fields in Wyoming also produce from below the Mississippian in rocks of Devonian and Ordovician age.) Depths to production range from 9,000 to 15,000 feet.

Drilling in this area is very difficult. Weather is a factor at an elevation of 8,000 feet, often helicopters are necessary to bring in supplies, and crooked hole drilling is commonplace in drilling these holes. With the difficulties of drilling and the extreme depth to pay, these wells are very expensive. Costs are approximately 4 million dollars for a dry hole and 10 million dollars for a producer.

OTHER AREAS

SEVERAL additional drilling programs outside these production areas are also of great interest. Amoco Production Company drilled a series of 15 holes on the Great Salt Lake from 1978-80. Amoco mounted a large drill rig on a barge, floated it to a drill site, and anchored it by cables to piles driven into the lake bottom. Two of these holes produced a heavy, black, tarry, sulfurous oil from fractured basalt at depths of 2100 to 2300 feet. Evidently the volume was not sufficient to be commercial and the wells were plugged and abandoned.

Utah Petrochemical, a corporation from Ogden, Utah, has perfected a process for refining this heavy oil and has acquired some of Amoco's leases and are contemplating drilling a series of shallow tests.

In the central portion of the Basin and Range Province, along the hingeline, Placid Oil drilled a series of ten holes to explore the central Utah Thrust Belt. All of these holes were plugged and abandoned but lithology similar to the producing wells of the thrust belt to the north was encountered.

SUMMARY

THE decade (1972-82) has shown a flurry of oil and gas activity within the State and the number of holes drilled per year has shown a steady increase.

With the infill drilling at the Altamont-Bluebell complex, the extensive activity in south Duchesne County, the continued drilling in the Paradox Basin, and the activity in the Thrust Belt area, this upward drilling trend should continue into the future.

Another factor helping the renewed activity is the steady increase in price of oil and gas at the well head.

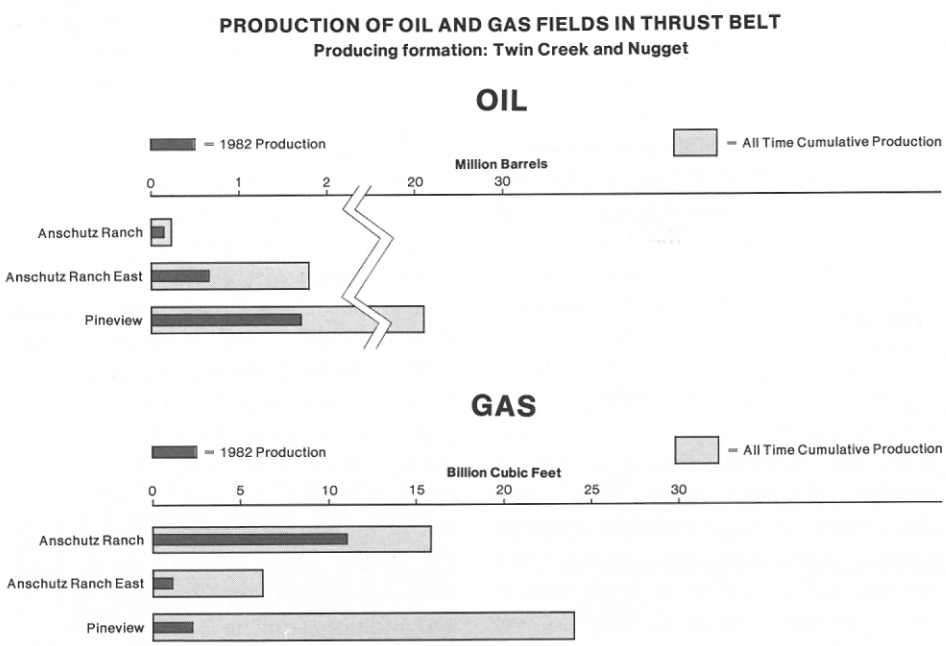

FIGURE 5.

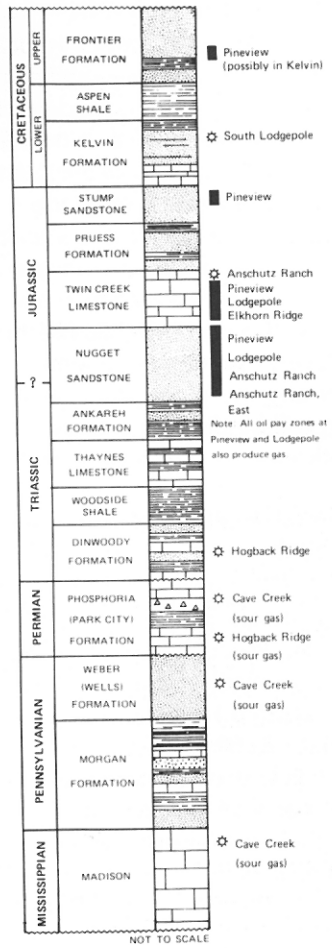

FIGURE 6.

The production graphs (figs. 7 and 8) show the oil and gas volume produced in Utah for each year 1972 through 1982. In 1982, the total for the State was 23.9 million barrels of oil and 99.5 billion cubic feet of gas.

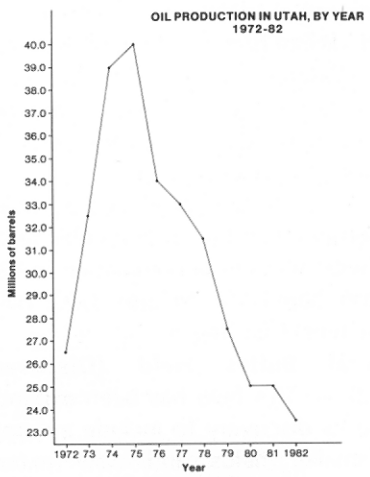

FIGURE 7.

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THE ALTA CONFERENCE

The Alta Conference convened in July 1984, to discuss priorities for geologic investigations in Utah. The following articles are three of six which summarize the findings of these working groups. In the Winter issue of ***Survey Notes****, the last three reprints will be published.*

STRUCTURE AND COMPOSITION OF THE CRUST

By RONALD L. BRUHN [1]

RESEARCH into the structure and composition of the earth is fundamental to understanding the origins of natural resources, designing structures in rock, and developing models for the evolution of the crust. The panel discussion on structure and composition of the crust identified four broad areas of research with significant potential for both basic and applied research in Utah. These topics were 1) geotectonics of sedimentary basins, 2) structure and thermal-chemical evolution of magmatic systems, 3) evolution of the Mesozoic to Early Tertiary fold and thrust systems in Utah, and 4) rheological properties of the crust. The panel was unanimous in agreeing that future research will demand integrated studies involving the joint participation of scientists from several disciplines, including structural geology, geophysics, geochemistry, and sedimentary, metamorphic, and igneous processes. Research into regional structure and crustal composition should concentrate on relating deep crustal structures and processes to those observed in the near surface. Consequently, a large component of geophysical and geochemical research will be required, particularly deep seismic imaging of the crust, modelling of thermal fields, measurements of stresses at depth, and modelling of chemical systems. Providing adequate resources, and administrative and work environments conducive to such integrated programs will be a fundamental challenge for the earth science community.

Rationale for Future Research

1. **Geotectonics of sedimentary basins** — Sedimentary rocks form the most

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[1] Associate Professor of Geology, University of Utah.

DATING GEOLOGIC MATERIALS IN UTAH

By DONALD R. CURREY [2]

GEOCHRONOMETRY—measuring or closely estimating the ages of geologic materials, and of the processes that have affected those materials, by rigorous use of appropriate techniques—is essential to a working understanding of Utah's geologic history. Frequently, geochronometry is a key to unlocking the State's mineral resources. Almost by definition, geochronometry is a prerequisite to assessing and mitigating the State's geologic hazards. On July 10, 1984, at Alta, Utah, the Utah Geological Workshop on "Dating Geologic Materials" arrived at several recommendations for expediting applications of geochronometry in Utah; those recommendations are outlined below.

Gathering, Storing, Retrieving, and Disseminating Geochronometry Information

The fact that none of these functions is currently being performed, or ever has been performed, on a systematic basis for geochronometry information pertaining to Utah results in costly inefficiencies and lost opportunities to all segments of the geologic community within the State. GENERAL RECOMMENDATION: Utah Geological and Mineral Survey (UGMS) is the most, and perhaps only, logical clearinghouse for performing these functions. To implement this general recommendation, the workshop offers the following specific recommendations:

1) An annual catalog of information relating to geochronometric determinations on samples collected in Utah and reported to

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[2] Associate Professor of Geography and Department Chairman, University of Utah.

GEOLOGIC HAZARDS

By ROBERT W. FLEMING [3]

THE current climatic cycle that has produced unprecedented landsliding, floods, high ground-water levels, and a 20th-century-record level of the Great Salt Lake has resulted in hundreds of millions of dollars in damages and heightened the awareness of our vulnerability to geologic hazards.

The 1983 earthquake in sparsely populated south-central Idaho was a reminder that the most serious hazard to Utah's populated areas is a major earthquake. Workshop participants strongly endorsed the U.S. Geological Survey program of earthquake studies that will provide support for basic research, hazard evaluations, and information dissemination.

For all hazards investigations, there is a need for both basic research to better understand the causes and effects of the hazardous processes and applied research to identify areas of different relative hazard. The results of different research strategies will produce benefits to the scientific community and the general public. Results of basic research will lead to improved assessments of hazards. The application of existing technology would permit useful delineations of areas that could experience damage from different hazardous processes.

Because Utah is experiencing conditions that lead to unprecedented damages from certain types of geologic hazards, there is a unique opportunity for research. Scientists and engineers should be encouraged to take advantage of research opportunities and to make the results of their work available through publication of the results. There is a critical need to document the recent events at least in terms of type of

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[3] Geologist, U.S. Geological Survey.

STRUCTURE AND COMPOSITION

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voluminous component of the upper crust and are the source for mineral, coal, petroleum, and water resources. The use of sedimentary rocks for storage of resources and wastes is increasing in Utah, and will undoubtedly become more important in the near future. Certainly, understanding the origin, evolution, chemical-mechanical properties, and hydrology of sedimentary basins in Utah is an important topic for academic and governmental agencies.

The panel recognized the importance of studying all types of sedimentary basins but agreed that the young, Tertiary extensional basins of western Utah represent a frontier area of research that requires attention in the near future. Extensional rift basins are now recognized worldwide as fundamental features in the evolution of the crust and as important potential sites of mineral, petroleum, and geothermal resources. Tertiary rift basins in Utah have received only cursory attention by academic and governmental agencies to date, although exploration work by industry has already been extended into these regions. Research in these areas will of necessity be related to fundamental problems in basin evolution and therefore should be initiated by the academic community and USGS personnel involved in developing geotectonic models of basin formation and crustal fault systems.

Studies of other basins in Utah are also important, as noted by the Workshop on Sedimentary Basins. In particular, studies of sedimentary basins in the Mesozoic and Early Tertiary thrust systems and Paleozoic basins associated with development of the Ancestral Rocky Mountains have important implications for understanding crustal evolution and the origin of petroleum and other resources.

High priority should be given by UGMS to developing an adequate base of data for evaluating the structure and thermal and hydrologic state of basins where nuclear- or other hazardous-waste isolation projects have been, or will likely be, proposed. This suggestion, which came from the panel on Sedimentary Basins, is consistent with the views of those attending the Structure and Compositions workshop.

2. Structure and thermal-chemical evolution of magmatic systems — The generation and emplacement of magma in the crust is a fundamental process in crustal evolution. Particularly significant problems in Utah include the origin of ore deposits in magmatic systems and the relation between crustal dilation, magma emplacement, and crustal faulting. This latter topic has major implications for understanding the development and location of mineral deposits and geothermal reservoirs. Thermal processes associated with magma generation and emplacement are also responsible for determining spatial and temporal histories of maturation of organic materials, geochemical alteration and mineralization, and the evolution of fracture systems which control the hydrologic properties of the crust in the brittle regime. Seismicity is strongly influenced by the rheological state of the crust, which is directly related to its composition and thermal and stress state.

The historically important mid-Tertiary and younger mineral belts of Utah were cited as high-priority research targets for integrated geological, geophysical, and geochemical studies of crustal structure and composition during the workshop. Indeed, such mineral belts are important worldwide and therefore represent attractive regions for combined basic and applied research programs. Utah's mineral belts provide an excellent opportunity to combine the results of surface geologic mapping, geochemical studies, and new, high-resolution techniques of deep seismic imaging to advance our knowledge of crustal evolution and mineral resource development. The CUSMAP program of the USGS, together with quadrangle mapping projects involving the UGMS, USGS, and academic personnel can provide the necessary mapping base for these new studies. Geochemical, seismic imaging, and modelling of crustal structure, composition, thermal state, and rheology would be the venue of the academic community and qualified personnel within the USGS. A major role for UGMS and USGS personnel would be ensuring that the new information was transmitted to the mineral industry in a timely and informative manner.

3. Mesozoic and Early Tertiary Thrust Systems — Discrete thrust sheets involving large volumes of sedimentary and crystalline rock have long been recognized as fundamental crustal features of importance in Utah. Evolution of this thrust system during the Mesozoic and Early Tertiary resulted in structural and composition layering of the crust and formation of important petroleum resources, and presumably provided fracture systems of regional importance to later mineralization. Reactivation of thrust faults during Tertiary extension may control the location and geometry of younger fault systems, and this has important implications for the formation of Tertiary basins and earthquake generation. Synorogenic deposits eroded from uplifted thrust sheets accumulated in basins which contain important quantities of petroleum resources.

New studies should emphasize the influence of chemical, thermal, and mechanical processes in the origin and evolution of these large thrust sheets. Important topics include crustal rheology, the evolution of fracture systems in thrust sheets, maturation of source rocks, fluid migration history, and diagenesis of rocks both in thrust sheets and adjacent foreland basins.

The structure and distribution of major thrust sheets in western Utah, where young Tertiary extensional basins have been superimposed upon this older terrane is a frontier area for petroleum resource exploration. Increased industry interest in this region requires that the UGMS encourage and keep abreast of new research in western Utah. In addition, studies of fault-zone rheology and the potential for reactivation of older structures will be fundamental to earthquake hazards investigations.

Multidisciplinary studies in thrust systems will require significant resources in personnel and funding. The UGMS has a major potential role in this work. In particular, the quadrangle mapping program will contribute to this topic, and the Survey's coal lab has the capability of providing significant new data on thermal maturation histories of sedimentary rocks. Also, the UGMS may provide the outlet for topical maps constructed by academic personnel.

4. Crustal Rheology — This topic deals with the processes of rock deformation. The manner in which rocks deform is dependent on composition, stress state, strain rate, thermal regime, and fluid pressure and chemistry. Rapid advances are being made in the field of rheology with major implications for understanding the evolution of faults and joints and origins of earthquakes. This work, in turn, will strongly affect analyses of earthquake hazards, reservoir stability and stimulation, mine design, in-situ mining, the structural evolution of ore deposits, and fracture permeability in thrust sheets and sedimentary basins. A key problem facing the academic and governmental organizations in Utah is seeing that the results of theoretical and experimental studies on crustal rheology are utilized in hazards assessment, site evaluation, and design studies.

Much of this work will be done by the academic community. An important role for the UGMS will be identifying those projects in which state-of-the-art analyses of seismicity, stress state, deformation rates, fracture

systems, and other structures are required, and ensuring that qualified personnel are involved as necessary.

A consensus of the workshop was that the UGMS could play several important roles in projects involving the structure and composition of the crust. Key roles could be:

1) Continuation of the quadrangle mapping program.

2) Creating new maps and portfolios containing combined geological and geophysical data sets. A concensus of the workshop was that classical geologic maps will continue to be essential, but new types of data, particularly emphasizing the three-dimensional nature of crustal structures will be required. The UGMS must consider the near future, when technical people will have to deal with multiple-data sets on a routine basis.

3) UGMS should become a depository of data. Particularly important information will include petrophysical information from well logs, cuttings, and core. Geotechnical data on rock strength and stress measurements from mines and other sites would also be important to collect on a routine basis.

4) UGMS should attempt to establish a program whereby thermal measurements can be made in drill holes on a routine basis.

5) The vitrinite reflectance lab of the UGMS could play a major role in providing data and analyses on the thermal history of sedimentary rocks from basins and thrust sheets.

6) Providing means for the interchange of ideas and data between industry personnel, and academic and government researchers in Utah.

7) Provide support for topical research above that of the quadrangle mapping effort. Structural and geochemical studies can provide essential information for geotechnical problems. ■

DATING GEOLOGIC MATERIALS

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UGMS during a particular year should be compiled and published as a serial publication by UGMS. It has been suggested that an appropriate title for this publication series might be ***Utah Geochronometry.*** To ensure that dissemination of information by means of this medium is implemented with a minimum of delay, initially this publication should be compiled from manuscript by word processor; later the information should be permanently stored in, and be retrieved for publication from, a computerized data base. The annual catalog should be designed to facilitate use by the widest possible spectrum of potential users. The format for each entry should provide for complete reporting of the age determination and of essential ancillary data, and should provide for citing pertinent references; a bibliography that includes all pertinent references should be an integral part of the annual catalog.

2) An occasional catalog of information having to do with performing and reporting age determinations on samples from Utah should be compiled and published every few years by UGMS. An appropriate title for this publication series might be ***Utah Geochronometry Manual.*** The manual should be instructive in several specific categories. Step-by-step instructions for applying each major geochronometry technique should be provided. These instructions should include: factors to be considered in selecting a technique (such as cost, time required, and sample size); collecting, handling, processing (pretreating), packaging, and shipping samples; describing the geologic and locational context of each sample; and factors to be considered in evaluating results. Woodward-Clyde has an in-house manual along these lines that might serve as a model. The UGMS manual should provide a directory of persons who are experienced in applying each major technique and who have agreed to serve as informal consultants to colleagues who contemplate applying particular techniques to geologic materials in Utah. The manual should also provide selected references to literature that might be particularly instructive to users in Utah. Furthermore, the manual should provide a relatively complete directory of laboratories, both commercial and institutional, that perform age determinations. This manual would be an appropriate place to set forth guidelines for the standardized reporting of Utah age determinations and essential ancillary data to UGMS for inclusion in ***Utah Geochronometry.***

3) A panel of specialist advisors, representing each of the major geochronometry techniques, should be enlisted to assist UGMS in implementing, both initially and on a continuing basis, recommendations (1) and (2), above. The advisory panel could well be the same persons as those comprising the directory of informational consultants mentioned in recommendation (2).

4) The effectiveness of UGMS as a clearinghouse in the roles described above will be enhanced by interfacing where feasible with geochronometry data bases that already exist; potential opportunities would include ***Isochron West*** and the USGS volcanic ash catalog maintained in Denver by Glen Izett.

5) The effectiveness of UGMS as a clearinghouse will be further enhanced by making a special effort to document age determinations and their localities to the fullest possible extent on Utah maps, sections, columns, correlation charts, and site reports. The determinations and localities that should be documented routinely in UGMS media include not only radiometric dates, but tephra occurrences, magnetostratigraphic occurrences, aminostratigraphic occurrences, and other rapidly accruing types of geochronometry information.

6) A special service would be provided by UGMS in the clearinghouse role by periodically compiling and publishing master stratigraphic sections, perhaps for each geologic era and/or each geologic province of the State, that include an up-to-date selection of benchmark geochronometric calibration from that time span and/or that region of the State.

7) UGMS would provide a similarly special, and potentially invaluable, service by compiling and publishing, as opportunities arise, a series of site-specific measured sections that indicate in detail the stratigraphic context of selected geochronometric determinations, and conversely, the geochronometric context of certain unusually complete or well-exposed reference sections. Such geochronometry-calibrated detailed sections would be particularly useful for resolving misunderstandings and lacunae of understanding that are widespread with respect to relatively young materials that are prone to disruption by near-surface geologic processes or by near-surface manifestations of processes having deeper origins.

High-Priority Geochronometry

For several reasons, the Workshop recommends that the geochronometry of Tertiary and, particularly, Quaternary non-marine sedimentary rocks be given first claim on the geochronometry budget resources of UGMS. These are the relatively unconsolidated basin-fill units and upland-surficial geologic units that contain most of Utah's ground water, that provide the substrate for most of the State's arable land, that constitute the sites for most of the State's urbanization, that most vividly reflect the State's neotectonic history, that comprise the State's high-risk areas for a multitude of geologic hazards, and that offer the best basis for reconstructing the State's relatively recent paleoenvironmental past as a means, perhaps, of more wisely anticipating the State's neoenvironmental future. ■

GEOLOGIC HAZARDS

Continued from Page 7

process, location, and significance.

The workshop group endorsed the findings of the Governor's Conference on Geologic Hazards, which were published in UGMS Circular 74. The group recommended that research activities be directed toward the specific recommendations in Circular 74.

The achievement of a reduction of damages from geologic hazards depends at least as much on the users of research information as on the producers. There is a need to transmit information to other governmental officials and the public in a form that can be utilized for damage reduction. There are several options for governmental action that can achieve varying degrees of damage reduction. These range from adoption and enforcement of strict grading and building codes that have proven effective in other parts of the United States to release of hazards information to libraries and local governmental offices. The options selected must have the support of governmental officials and the general public to be successful.

Discussion

The State of Utah has experienced in 1983 and 1984 two consecutive years of geologic disasters. The cost of damages to both public and private property has been immense. The types of hazards that represent the most serious threats to life and property include earthquakes, all types of landslides, floods, high ground-water levels, expansive soils, collapsing soils, and snow avalanches. The U.S. Forest Service has sharply curtailed research on snow avalanches and the Utah Geological and Mineral Survey (UGMS) should determine whether research sponsored by the State of Utah should be initiated.

A large part of the western United States is experiencing a climatic wet cycle. During a wet cycle, annual precipitation generally exceeds the long-term average for several years, and hazardous geologic processes that are stimulated by a surplus of water produce a variety of damages. In Utah, precipitation in 1983 and 1984 greatly exceeded long-term averages. Precipitation during the water year of 1983 established the all-time record. This has resulted in unprecedented amounts of flooding and landsliding, and triggered a rise of more than 9 feet in the Great Salt Lake. While the flooding in Salt Lake City, landslides in Spanish Fork and Twelve-mile Canyons, and debris flows in Davis County received national attention, numerous other hazards caused widespread damage. More than 75 percent of Utah was included in a Presidential disaster declaration in 1983, and the Utah Department of Public Safety has estimated damages at $478 million. Losses from hazards in 1984 were significantly less. However, the inexorable rise of the Great Salt Lake and rising ground-water levels added to less-severe flood and landslide problems produced tens of millions in damages.

On October 28, 1983, a major earthquake occurred in neighboring Idaho. The geologic setting of this earthquake is similar to that of the major population centers of Utah and provides a demonstration of what can be expected along the Wasatch Front. Although the Idaho earthquake was located in a sparsely populated area and was over 20 miles from the nearest town, two children were killed and extensive damage occurred over a wide area. A similar earthquake in a densely populated portion of the Wasatch Front would be a major disaster. In fiscal year 1984, the Earthquake Hazard Reduction Program of the U.S. Geological Survey (USGS) sharply increased research on earthquakes along the Wasatch Front. Over a three year period, about $7.5 million will be expended in basic research, hazard evaluations, and information dissemination. The work will be conducted by the USGS, UGMS, the various universities, and private consultants.

BECAUSE OF THE service responsibility of the UGMS to the people of Utah, it is appropriate that they obtain most of the information necessary for hazard reduction. The USGS, on the other hand, has a mission in basic research and generally obtains information to be used by other scientists. This distinction in respective roles of UGMS and USGS for study of geologic hazards is not sharply defined and several studies of a distinctly basic nature are being conducted by the UGMS and some applied studies are being conducted by the USGS.

Basic geologic information is needed for both types of studies and the workshop group strongly supported the UGMS program of bedrock and surficial geologic mapping. In particular, the plan to subdivide Quaternary map units for engineering purposes was applauded.

Important studies are underway by the UGMS, USGS, U.S. Forest Service, and university faculty and students. There is a critical need to document the recent events at least in terms of type of process, location, and significance.

On August 11-12, 1983, the UGMS sponsored a Governor's Conference on Geologic Hazards. The conference was attended by more than 200 persons representing virtually every level of government, private consultants, teachers, and public citizens. Through a series of 41 working group discussions, specific recommendations were offered for research, improvements in disaster response, and programs to reduce the damages caused by future events. The results were published in UGMS Circular 74. Perhaps part of the improved response to the problems of 1984 was a result of the information exchanged at the conference. The continuation of such conferences is encouraged. Future research activities should be directed toward the specific recommendations in UGMS Circular 74.

Significant reduction of damages from geologic hazards can be achieved. Where programs have been successful, they contained three essential elements. These are 1) an adequate basis of technical information about specific hazards, 2) qualified scientists and engineers in the area that are able to utilize the basic information and obtain the necessary additional data relevant to specific locations, and 3) local governmental officials and a general public that support programs in loss reduction. It is the responsibility of the UGMS to develop the technical information that identifies hazardous areas and assesses the relative severity of hazard in different geographical areas.

It is not certain that there is sufficient support in local government and among the general public to adopt programs that restrict how land may be utilized. Other than a restrictive zoning and permitting program that must be managed by local government, there are several options for achieving damage reduction. These include: a) providing information about hazardous areas to lending institutions, b) attachments to property deeds of statements about potential hazards on the property that must be acknowledged during sale or transfer of property, and c) providing information on hazards for interested people at the local governmental offices and libraries. Other possibilities are outlined in UGMS Circular 74. A bill was introduced in the 1984 session of the Utah legislature that would require the UGMS to identify and provide the public with the locations of geologic hazards in the State. Although it did not pass the first time it was introduced, it will be reintroduced during the next legislative session. Passage of that bill is a necessary step in a program to reduce losses and avoid damages from geologic hazards. ■

UTAH EARTHQUAKE ACTIVITY

July 1 to September 30, 1984

By WILLIAM D. RICHINS[1]

THE University of Utah Seismograph Stations records a 75-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho and western Wyoming. During July 1 to September 30, 1984, 128 earthquakes were located within the Utah region (fig. 1).

The largest earthquake during this time period occurred on August 16, 1984 12 miles south of Levan near the Wasatch Fault. This earthquake had a magnitude of 3.7 and was felt in Levan, Gunnison, Ephraim, Manti, and other nearby communities. A total of three earthquakes were reported felt in the Utah region during this time period. Other significant aspects of earthquake activity shown in figure 1 include (from north to south):

1. a magnitude 3.0 earthquake northwest of Tremonton on August 6,
2. a magnitude 2.8 earthquake approximately 35 km west of Brigham City on September 30,
3. a magnitude 2.3 earthquake approximately 25 km west of Salt Lake City near Magna on September 5,
4. clustered small magnitude earthquake activity in the vicinity of active coal mining northwest and southwest of Price in central Utah, and
5. on-going activity scattered throughout a northwest-southwest trending belt between Richfield and Cedar City in southwest Utah.

A new earthquake bulletin titled "Earthquake Data for the Utah Region, January 1, 1981 to December 31, 1983" was published in August, 1984, by the University of Utah Seismograph Stations. A limited number of these volumes are now available at the Utah Geological and Mineral Survey. Additional information on earthquake data within Utah is available by contacting the University of Utah Seismograph Stations, Salt Lake City, Utah 84112 (801) 581-6274. ■

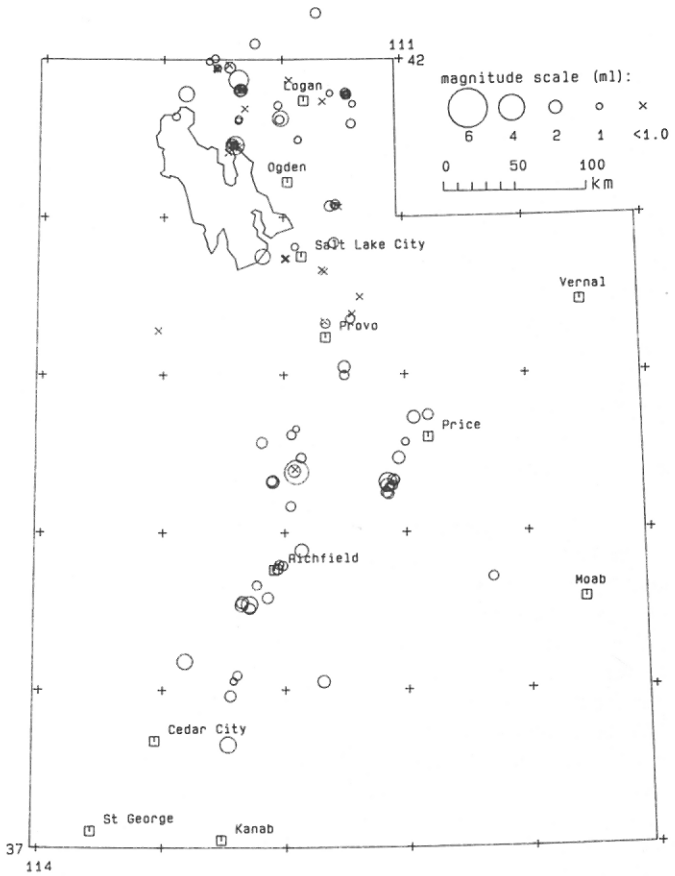

FIGURE 1. Utah earthquakes: July 1 - September 30, 1984

[1]Senior staff seismologist, University of Utah Seismograph Stations.

FROM THE DIRECTOR'S DESK

Continued from Page 2

up data and maps.

The Alta workshop met my most optimistic expectations. It defined long-term goals for UGMS scientific studies and has provided me with rhetoric and ideas with which to argue for funding and staffing for the UGMS. The workshop also succeeded in developing communication among earth scientists, and defining priorities for non-UGMS investigations.

This issue of *Survey Notes* carries three (please see page 7) of the six working group reports. The next issue will carry the three remaining reports on Hard Rock Resources, Sedimentary Rock Basins, and Surface Mapping. At first we considered only a limited distribution of the workshop's findings. However, the UGMS Review Committee considered the workshop's results to be of sufficiently wide-spread interest to have them printed in *Survey Notes*.

Miriam Bugden, UGMS geotech/receptionist, made all the arrangements for the workshop. Hank Goode, consulting geologist, edited the six reports that were prepared by the working session chairmen. ■

Genevieve Atwood

PETROLEUM ACTIVITIES

Continued from Page 6

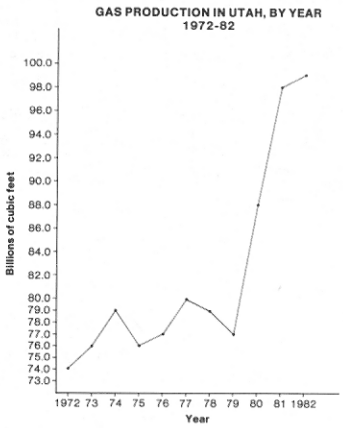

FIGURE 8.

The decline in production of oil since 1975 may be reversed somewhat when the full production from the Thrust Belt comes onto stream. The increase in production of gas will continue to rise with the new Thrust Belt production. Companies active in the area are just now completing facilities to handle the increased production.

The favorable growth of the oil and gas activity within Utah during the past decade should extend into the future, and it is this writer's opinion that the industry will progress to even a higher degree as we proceed into the next decade. ■

UGMS STAFF CHANGES

The following staff changes have taken place since last issue:

Roselyn Dechart, former secretary to the Applied Geology and Information programs, has assumed the position of Records Manager/Executive Secretary to UGMS Director, Genevieve Atwood. Filling the secretary position is **Brenda Jacobson**, originally from Cody, Wyoming, who has an associate degree from BYU in secretarial technology. Brenda has been in Utah on and off for six years, is a jazzercize instructor, and enjoys dance, travel, and camping. The Site Investigations Section has added **Kimm Harty** to their staff. Kimm is from Long Island, New York, but comes to us from the University of Alberta where she earned her master's degree in geomorphology. She writes songs (music and lyrics - composing on her guitar) and enjoys traveling and running. ■

NEW PUBLICATIONS

- **Water-Resources Bulletin 24,** *Floods of May to June 1983 along the northern Wasatch Front, Salt Lake City to North Ogden, Utah,* by K. L. Lindskov of the USGS Water Resources Division, 12 p., 7 figs., 2 tables. Price $3.00 over-the-counter.

GREAT SALT LAKE LEVEL

Date (1984)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
Sept. 1	4208.15	4206.60
Sept. 15	4208.00	4206.85
October 1	4207.85	4206.90
October 15	4207.90	4207.00
November 1	4208.05	4207.05
November 15	4208.20	4207.20

SOURCE: U.S. Geological Survey provisional records.

UTAH NATURAL RESOURCES
Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, UT 84108-1280
Address correction requested

Bulk Rate
U.S. Postage Paid
S.L.C., Utah
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